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国产毛茛科升麻属四种植物的核形态研究，并略论升麻的细胞地理*

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Karyomorphology of four species in *Cimicifuga* (Ranunculaceae) from China, with some cytogeographical notes on *C. foetida*

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Abstract In this paper, four species of the genus *Cimicifuga* L. from China(*C. acerina*, *C. simplex*, *C. yunnanensis*, *C. foetida* var. *foetida* and *C. foetida* var. *velutina*) were karyomorphologically investigated. All the taxa studied had the same chromosome number of 2n=16 except for *C. foetida* var. *foetida*, in which a tetraploid cytotype was found to occur in northwestern Yunnan. Their karyotypes are all presented. The chromosome counts in *C. yunnanensis* and *C. foetida* var. *velutina* are reported here for the first time.
Key words *Cimicifuga*; *C. foetida*; Karyomorphology; Cytogeography
摘要 本文研究了国产四种升麻属植物(小升麻、单穗升麻、云南升麻、升麻及其变种毛叶升麻)的核形态。除发现升麻在云南西北部地区有二倍体和四倍体两种细胞型存在外,其他类群都为二倍体。云南升麻和毛叶升麻的染色体数目和核型为首次报道。
关键词 升麻属;升麻;核形态;细胞地理

The genus *Cimicifuga* L. of the Ranunculaceae, including about 18 species, is widely distributed in the northern hemisphere(Tamura, 1995). Eight species have been recorded in China(Xiao, 1978). Although most of the species in this genus have been cytologically studied(Wang *et al.*, 1994; Emura, 1970a, 1970b, 1970c; Hasegawa, 1969; Kurita, 1957), they are only very limitedly sampled, particularly for those in China. As is well known, polyploidy is not common in the genus *Cimicifuga*, but in *C. foetida*, which is highly variable in gross-morphology, Hasegawa(1969) reported a tetraploid cytotype from Thimphu, Bhutan and, based on an examination of the size of pollen grains and stomata, she further inferred that the plants of this species from the Himalayas, Myanmar and Yunnan might be also tetraploids. However, her inference was not confirmed by her study on the plants from the Darjeeling District, India(Emura, 1970a). She pointed out that further cytological research of the materials from Asia, particularly from Yunnan, are quite necessary. This paper is to report the results of a karyomorphological study on four species in *Cimicifuga* from China, with much attention to the ploidy variation of *C. foetida*.

* 中国科学院资源与环境重点项目资助的课题。
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1 Materials and Methods

All the plants studied were collected in the field from China(Table 1). The taxonomic treatments provisionally followed Xiao(1978), because in the very recently published taxonomic revision of the genus *Cimicifuga* (Compton *et al.*, 1998; Compton & Hedderson, 1997), I found some Chinese species, such as *C. mariei*, *C. frigida* and *C. brachycarpa*, were rather ill-delimited and the taxonomic treatments seem to be more confusing than before.

The plants were cultivated in pots in the experimental garden of Kunming Institute of Botany, the Chinese Academy of Sciences, before their root tips were harvested for the cytological study. Actively growing root tips were pretreated in 0.1% colchicine at about 20℃ for three hours before they were fixed in Carnoy I(glacial acetic acid:absolute ethanol=1:3) at 4℃ for 30 minutes, then they were macerated in 1:1 mixture of 1 mol / L hydrochloric acid and 45% acetic acid at 60℃ for two minutes, and stained and squashed in 1% aceto-orcein.

Karyomorphological classification of resting nuclei and mitotic prophase chromosomes followed Tanaka(1977, 1971). Karyotype formulas were based on the data of measurements of mitotic metaphase chromosomes(some examples were made in tables 2～5; all the data are not presented in this paper). The symbols used to describe the karyotypes followed Levan *et al.*(1964).

The voucher specimens were deposited in the Herbarium of Institute of Botany, the Chinese Academy of Sciences(PE).

Table 1 Chromosome counts and source of materials studied

Taxon	Provenance	Voucher	2n
Cimicifuga acerina	Xinning County, Hunan Province	Y. B. Luo 947	16
C. simplex	Zhani, Muli County, Sichuan Province	Q. E. Yang 9326	16
C. yunnanensis	Wutoudi, Mt. Yulongshan, Lijiang County, Yunnan Province	X. Gong 9215	16
	Bitahai, Zhongdian County, Yunnan Province	Q. E. Yang 9492B	16
C. foetida var. *foetida*	Xiaohuadianba, Mt. Cangshan, Dali City, Yunnan Province	Q. E. Yang 9360	16
	Napahai, Zhongdian County, Yunnan Province	Q. E. Yang 9488	16
	Bitahai, Zhongdian County, Yunnan Province	Q. E. Yang 9492A	16
	Mazhixiang, Daofu County, Sichuan Province	Y. B. Luo 89	16
	Mengda, Xunhua County, Qinghai Province	Q. E. Yang 9508	16
	Huadianba, Mt. Cangshan, Dali City, Yunnan Province	Q. E. Yang 9436	32
var. *velutina*	Wenhai, Mt. Yulongshan, Lijiang County, Yunnan Province	Q. E. Yang 94138	16

2 Results and Discussion

2.1 Karyomorphology of resting nuclei and mitotic prophase chromosomes

All the taxa studied were basically similar in karyomorphology of resting nuclei. In resting nuclei(Fig. 1:2; Fig. 3:3), numerous chromocenters were observed. The other regions were also stained well but unevenly. Thus, the resting nuclei belonged to the complex chromocenter type.

All the taxa studied were also similar in karyomorphology of mitotic prophase chromosomes. In prophase chromosomes(Fig. 1:3; Fig. 3:4), hetero- and euchromatic segments were distinguishable, but their boundaries were not clear, and the heterochromatic segments

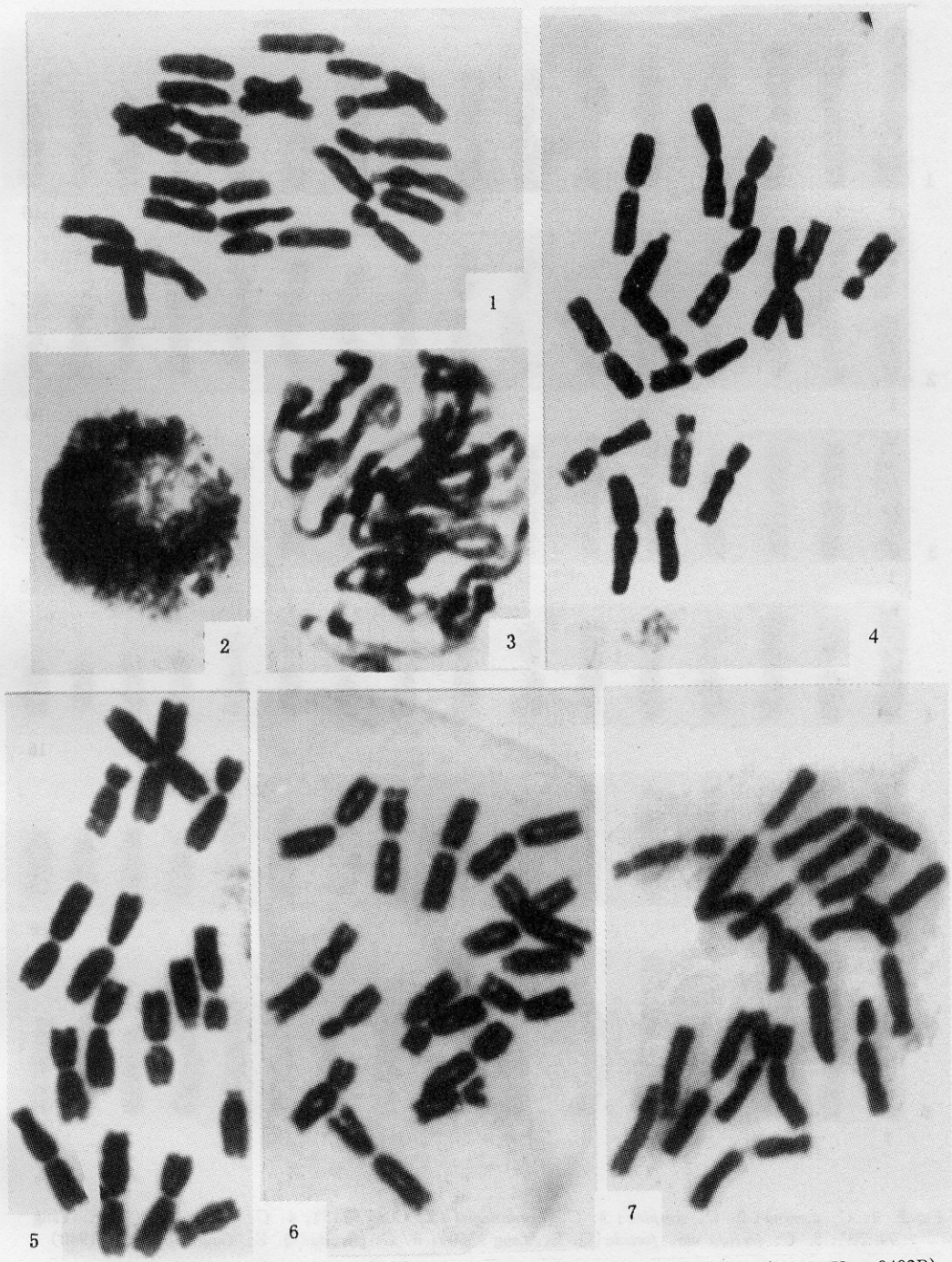

Fig. 1　1. *Cimicifuga simplex*; 2, 3, 4. *C. yunnanensis* (X. Gong 9215); 5. *C. yunnanensis* (Q. E. Yang 9492B); 6. *C. foetida* var. *foetida* (Q. E. Yang 9360); 7. *C. foetida* var. *foetida* (Q. E. Yang 9488) (all × 1940)

were distributed in the distal and interstitial regions as well as the proximal regions. Thus, the mitotic prophase chromosomes belonged to the interstitial type.

2.2　Metaphase chromosomes

2.2.1　*Cimicifuga acerina* (Sieb. et Zucc.) Tanaka

Fig.2 1. *C. acerina*; 2. *C. simplex*; 3. *C. yunnanensis* (X. Gong 9215); 4. *C. yunnanensis*(Q. E. Yang 9492B); 5. *C. foetida* var. *foetida*(Q. E. Yang 9360); 6. *C. foetida*(Q. E. Yang 9488)(all×1940)

The chromosomes were counted to be 2n=16(Fig.2:1), ranging in length from 11.34 to 6.44 μm. The chromosome change in length was gradual. The karyotype was formulated as 2n=16=10m+2sm+2st+2t(Table 2). The results are very similar to those reported respectively by Kurita(1957) and by Emura(1970b, 1970c), except that no satellites were observed in this study. According to them, one pair of median chromosomes(the fourth or the fifth pair) and one pair of terminal chromosomes(the eighth pair) have very small satel-

lites on the short arms. Wang *et al*. (1994) reported the karyotype of this species from Nanchuan County, Sichuan Province as 2n = 12m(sat) + 2sm + 2t, which appears to be considerably different from the present results, but the difference might be caused by artificial factors, such as the errors in the measurements of chromosomes. Indeed, the chromosomes used for karyotype analysis by Wang *et al*. (1994) seem to be too strongly contracted to allow making exact analysis.

2.2.2 *C. simplex* Wormsk. (Sieb. et Zucc.)Tanaka

The chromosomes were counted to be 2n = 16(Fig. 1:1; Fig. 2:2), ranging in length from 11.70 to 6.19 μm. Six chromosome pairs were obviously longer than the remaining two pairs. The karyotype was formulated as 2n = 16 = 10m + 4sm + 2t(1sat)(Table 2). A small satellite was observed on the short arm of the 15th chromosome. Wang *et al*. reported the karyotype as 2n = 10m(2sat) + 2sm + 2st + 2t(sec), with the fifth chromosome pair having satellites on the short arms and the shortest terminal chromosome pair having secondary constrictions on the long arms. Kurita(1957) studied the chromosomes of this species from Japan under the name *C. simplex* var. *ramosa* Maxim. and found that three median chromosome pairs(the fourth, the fifth and the sixth) have rather large satellites on the short arms, and the eighth pair has very small satellites on the short arms. Emura(1970b, 1970c) made a detailed study of the karyotype variations in this species from Japan with respect to the gross-morphological variations and geographical distribution. She found that there exist three slightly but distinctly differentiated karyotypes in this species on the basis of the differences in size of the satellites on the short arms of the sixth chromosome pair, and the karyotype variations are correlated to some extent with the gross-morphological variations and geographical distribution. In this study, no satellites were observed on the sixth chromosome pair. Certainly, more cytological studies are needed for a better understanding of the chromosomal variations in this species from China. It should be noted that taxonomically *C. simplex* is sometimes not easily distinguishable from *C. yunnanensis*, particularly for those plants from southwestern Sichuan and northwestern Yunnan . As far as the present results of the karyotype analysis of the two species are concerned, their karyotypes exhibited some slight differences at least in the satellite number and position(see below for the karyotype of *C. yunnanensis*). The most noteworthy common feature of their karyotypes was that in their chromosome complements there were six chromosome pairs obviously longer than the remaining two pairs.

2.2.3 *C. yunnanensis* Hsiao (Sieb. et Zucc.)Tanaka

Two populations were cytologically studied here. The chromosomes of the population from Yulong Snow Mountain, Lijiang County, northwestern Yunnan Province, were counted to be 2n = 16(Fig. 1:4; Fig. 2:3), ranging in length from 9.18 to 5.10 μm. The karyotype was formulated as 2n = 16 = 10m(2sat) + 4sm(2sec) + 2t(Table 3). Six chromosome pairs were obviously longer than the remaining two pairs. The seventh chromosome pair was slightly shorter than the eighth pair, and thus this pair actually should be arranged as the eighth pair if the chromosomes were aligned strictly by the order of chromosome size. For the convenience of comparison with the karyotypes of other populations studied here, it was arranged as the seventh pair. On each short arm of the fifth chromosome pair, a relatively large satellite was clearly visible. In the distal region of each long arm of the seventh chromosome pair a secondary constriction was observed.

Table 2 Parameters of chromosomes in *Cimicifuga acerina* and *C. simplex*

Chromosome No.	*Cimicifuga acerina* 2n = 16 = 10m + 2sm + 2st + 2t			*C. simplex* 2n = 16 = 10m + 4sm + 2t(1sat)		
	Relative length	Arm ratio	Type	Relative Length	Arm ratio	Type
1	4.05 + 3.70 = 7.75	1.09	m	4.02 + 3.91 = 7.93	1.03	m
2	3.88 + 3.84 = 7.72	1.01	m	3.91 + 3.88 = 7.79	1.01	m
3	4.09 + 3.17 = 7.26	1.29	m	4.19 + 3.14 = 7.33	1.33	m
4	4.09 + 3.08 = 7.17	1.33	m	3.84 + 3.46 = 7.30	1.11	m
5	3.88 + 3.17 = 7.05	1.22	m	3.70 + 3.35 = 7.05	1.10	m
6	3.52 + 3.35 = 6.87	1.05	m	3.63 + 3.39 = 7.02	1.07	m
7	3.24 + 3.21 = 6.45	1.01	m	3.84 + 2.86 = 6.70	1.34	m
8	3.52 + 2.82 = 6.34	1.23	m	3.77 + 2.76 = 6.53	1.37	m
9	3.52 + 2.82 = 6.34	1.23	m	3.39 + 3.04 = 6.43	1.12	m
10	3.35 + 2.96 = 6.31	1.13	m	3.39 + 3.04 = 6.43	1.12	m
11	3.79 + 2.15 = 5.94	1.76	sm	3.98 + 2.17 = 6.15	1.83	sm
12	3.61 + 2.11 = 5.72	1.71	sm	3.98 + 2.06 = 6.05	1.93	sm
13	4.05 + 1.20 = 5.25	3.38	st	3.14 + 1.22 = 4.36	2.57	sm
14	3.88 + 1.15 = 5.03	3.37	st	2.79 + 1.40 = 4.19	1.99	sm
15	4.18 + 0.58 = 4.76	7.21	t	3.84 + 0.52 = 4.36	7.38	t*
16	3.88 + 0.53 = 4.41	7.32	t	3.84 + 0.52 = 4.36	7.38	t

* indicating the satellited chromosome

The chromosomes of the population from Zhongdian County, northwestern Yunnan Province, were also counted to be 2n = 16(Fig. 1:5; Fig. 2:4), ranging in length from 8.87 to 4.18 μm. The karyotype was basically the same as that of the population from Lijiang County and formulated as 2n = 16 = 10m(2sat) + 4sm(2sec) + 2st(Table 3). Six chromosome pairs were obviously longer the remaining two pairs. A satellite was visible on each short arm of the fifth chromosome pair. In the distal region of each long arm of the seventh chromosome pair a secondary constriction was observed.

The chromosome number and karyotype of this species are reported here for the first time.

Table 3 Parameters of chromosomes in two populations of *Cimicifuga yunnanensis*

Chromosome No.	Population from Lijiang 2n = 16 = 10m(2sat) + 4sm(2sec) + 2t			Population from Zhongdian 2n = 16 = 10m(2sat) + 4sm(2sec) + 2st		
	Relative length	Arm ratio	Type	Relative Length	Arm ratio	Type
1	4.06 + 3.89 = 7.95	1.04	m	4.22 + 4.02 = 8.24	1.05	m
2	4.02 + 3.89 = 7.91	1.03	m	4.31 + 3.59 = 7.90	1.20	m
3	3.97 + 3.57 = 7.54	1.11	m	4.17 + 3.40 = 7.57	1.23	m
4	3.97 + 3.57 = 7.54	1.11	m	4.17 + 3.35 = 7.52	1.24	m
5	4.02 + 3.35 = 7.37	1.20	m	3.83 + 3.59 = 7.42	1.07	m
6	4.02 + 3.35 = 7.37	1.20	m	3.79 + 3.26 = 7.05	1.16	m
7	3.66 + 2.99 = 6.65	1.22	m	3.98 + 2.73 = 6.71	1.45	m
8	3.62 + 2.90 = 6.52	1.25	m	3.83 + 2.87 = 6.70	1.36	m
9	3.48 + 2.90 = 6.38	1.20	m*	3.35 + 2.64 = 5.99	1.27	m*
10	3.48 + 2.90 = 6.38	1.20	m*	3.35 + 2.59 = 5.94	1.30	m*
11	3.62 + 1.79 = 5.41	2.02	sm	4.31 + 1.92 = 6.23	2.25	sm
12	3.57 + 1.79 = 5.36	1.99	sm	4.07 + 2.01 = 6.08	2.02	sm
13	3.13 + 1.34 = 4.47	2.11	sm◆	3.07 + 1.44 = 4.51	2.13	sm◆
14	3.08 + 1.38 = 4.46	2.23	sm◆	2.97 + 1.20 = 4.17	2.48	sm◆
15	4.24 + 0.56 = 4.80	7.57	t	3.50 + 0.53 = 4.03	6.64	st
16	4.24 + 0.56 = 4.80	7.57	t	3.35 + 0.53 = 3.88	6.32	st

* indicating the satellited chromosome; ◆ indicating the chromosome with a secondary constriction on the long arm

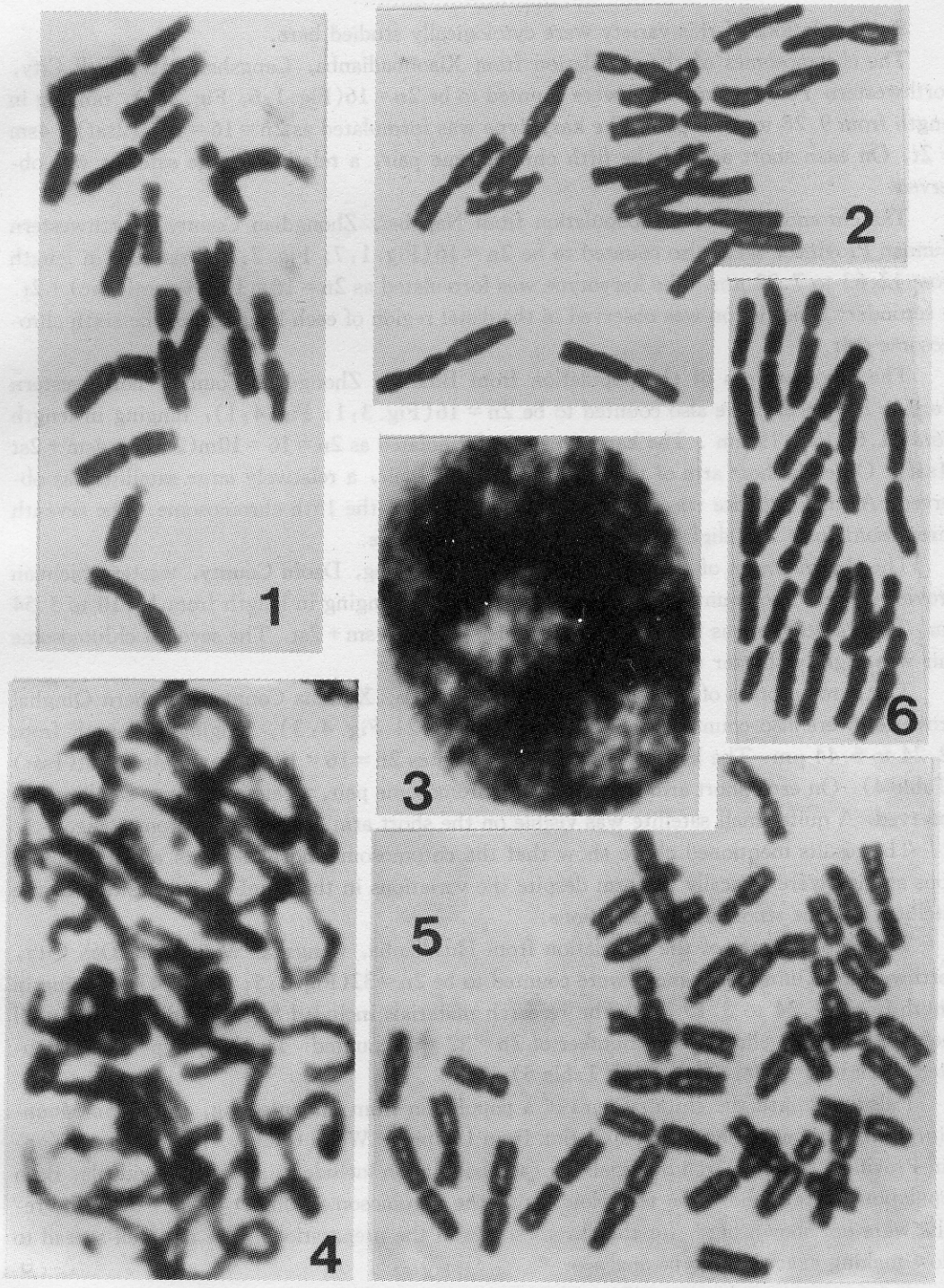

Fig. 3　1. *C. foetida* var. *foetida* (Q. E. Yang 9492A); 2. *C. foetida* var. *foetida* (Q. E. Yang 9508); 3, 4, 5. *C. foetida* var. *foetida* (Q. E. Yang 9436); 6. *C. foetida* var. *velutina* (all × 1940)

2.2.4　*C. foetida* L. (Sieb. et Zucc.) Tanaka

(a) var. *foetida*

Six populations of this variety were cytologically studied here.

The chromosomes of the population from Xiaohuadianba, Cangshan Mt., Dali City, northwestern Yunnan Province, were counted to be 2n = 16(Fig. 1:6, Fig. 2:5), ranging in length from 9.28 to 4.90 μm. The karyotype was formulated as 2n = 16 = 10m(2sat) + 4sm + 2t. On each short arm of the fifth chromosome pair, a relatively large satellite was observed.

The chromosomes of the population from Napahai, Zhongdian County, northwestern Yunnan Province, were also counted to be 2n = 16(Fig. 1:7; Fig. 2:6), ranging in length from 12.63 to 7.22 μm. The karyotype was formulated as 2n = 16 = 10m + 4sm(2sec) + 2t. A secondary constriction was observed in the distal region of each long arm of the sixth chromosome pair.

The chromosomes of the population from Bitahai, Zhongdian County, northwestern Yunnan Province, were also counted to be 2n = 16(Fig. 3:1; Fig. 4:1), ranging in length from 11.60 to 6.19 μm . The karyotype was formulated as 2n = 16 = 10m(2sat) + 4sm + 2st (1sat). On each short arm of the fifth chromosome pair, a relatively large satellite was observed. A small satellite was visible on the short arm of the 15th chromosome. The seventh chromosome pair was slightly shorter than the eighth one.

The chromosomes of the population from Mazhixiang, Daofu County, western Sichuan Province, were also counted to be 2n = 16(Fig. 4:2), ranging in length from 10.10 to 5.54 μm. The karyotype was formulated as 2n = 16 = 10m + 4sm + 2st. The seventh chromosome pair was slightly shorter than the eighth one.

The chromosomes of the population from Mengda, Xunhua County, southern Qinghai Province, were also counted to be 2n = 16(Fig. 3:2; Fig. 4:3), ranging in length from 12.24 to 6.44 μm. The karyotype was formulated as 2n = 16 = 10m(2sat) + 4sm + 2t(1sat) (Table 4). On each short arm of the second chromosome pair, a relatively large satellite was observed. A quite small satellite was visible on the short arm of the 15th chromosome.

The results mentioned above show that the chromosome morphology of all the populations studied were basically uniform despite the variations in the number and position of the satellites and the secondary constrictions.

The chromosomes of the population from Huadianba, Cangshan Mountain, Dali City, northwestern Yunnan Province, were counted to be 2n = 32(Fig. 3:5; Fig. 4:4), ranging in length from 11.34 to 5.15 μm. The research materials included 8 plant individuals. In all the plants a stable chromosome number of 2n = 32 was counted. The karyotype was formulated as 2n = 32 = 20m + 8sm + 4st(Table 5).

I also examined the chromosomes of a population from Zhonghefeng, Cangshan Mountain, Dali City, and those of a population from Lidiping, Weixi County, northwestern Yunnan Province. The research materials for each population included six plant individuals. Both populations were found to be tetraploids with the chromosome number of 2n = 32. The results were not shown here, for the chromosomes in the preparations were not well-spread to allow making exact karyotype analysis.

C. foetida is widely distributed in southern Siberia, Mongolia, Korea, the Himalayas, and northern, western and central China, and shows great gross-morphological variations, particularly in southwestern China, where several varieties have been recognized under this species(Xiao, 1978). As aforementioned, Hasegawa(1969) found the species from Thimphu, Bhutan to be tetraploids. She further inferred that the plants in the Himalayas, Myan-

Fig. 4　1. *C. foetida* var. *foetida*(Q. E. Yang 9492A); 2. *C. foetida* var. *foetida*(Y. B. Luo 89); 3. *C. foetida* var. *foetida*(Q. E. Yang 9508); 4. *C. foetida* var. *foetida*(Q. E. Yang 9436); 5. *C. foetida* var. *velutina*(all×1940)

mar and Yunnan might be also tetraploids, and those in Korea, Siberia and northeastern China might be diploids based on her studies on the variations of the size of stomata and pollen grains. Her inference was not confirmed by her cytological study on the plants from the Darjeeling District, India, which were found to be diploids(Emura, 1970a). The present results shows that the tetraploid plants of this species do occur in northwestern Yunnan and the diploid plants occur in southeastern Qinghai, western Sichuan as well as northwestern Yun-

nan(Fig. 5). Although on Cangshan Mountain, Dali City, both diploids and tetraploids have been found, the plants from a same population have very stable chromosome number, and the tetraploid populations are much more common on this mountain, where I have discovered five tetraploid populations but only one diploid population. In Lidiping of the Yunling Mountain, Weixi County, only tetraploid populations have been found. I expect that more tetraploid populations will be discovered in northern Myanmar, and China's northwestern Yunnan and southeastern Xizang(Tibet). It is noteworthy that the tetraploid populations are mainly distributed in the southern marginal parts of the distribution area of *C. foetida*.

Table 4 Parameters of chromosomes in *Cimicifuga foetida* var. *foetida* from Xunhua County, Qinhai Province and *Cimicifuga foetida* var. *velutina*

Chromosome No.	*Cimicifuga foetida* var. *foetida* 2n = 16 = 10m(2sat) + 4sm + 2t			*C. foetida* var. *velutina* 2n = 16 = 10m(1sat) + 4sm(1sec) + 2t(1sat)		
	Relative length	Arm ratio	Type	Relative Length	Arm ratio	Type
1	4.07 + 3.98 = 8.05	1.02	m	4.29 + 3.71 = 8.00	1.15	m
2	3.81 + 3.74 = 7.55	1.02	m*	4.39 + 3.41 = 7.80	1.28	m
3	4.07 + 3.47 = 7.54	1.17	m*	4.09 + 3.65 = 7.74	1.12	m
4	4.15 + 3.39 = 7.54	1.22	m	4.05 + 3.38 = 7.43	1.19	m
5	3.90 + 3.56 = 7.46	1.09	m	3.71 + 3.44 = 7.15	1.07	m
6	3.81 + 3.39 = 7.20	1.12	m	3.71 + 3.38 = 7.09	1.09	m
7	3.90 + 2.71 = 6.61	1.44	m	3.75 + 3.00 = 6.75	1.25	m*
8	3.81 + 2.71 = 6.52	1.40	m	3.75 + 2.70 = 6.45	1.38	m
9	3.56 + 2.71 = 6.27	1.31	m	3.71 + 2.70 = 6.41	1.37	m
10	3.36 + 2.71 = 6.07	1.24	m	3.31 + 2.83 = 6.14	1.16	m
11	3.98 + 1.87 = 5.85	2.13	sm	3.75 + 1.89 = 5.64	1.98	sm
12	3.81 + 1.87 = 5.68	2.04	sm	3.71 + 1.96 = 5.67	1.89	sm
13	2.97 + 1.53 = 4.50	1.94	sm	3.24 + 1.35 = 4.59	2.40	sm◆
14	2.97 + 1.53 = 4.50	1.94	sm	3.04 + 1.52 = 4.56	2.00	sm
15	3.90 + 0.51 = 4.41	7.65	t	3.78 + 0.43 = 4.21	8.79	t*
16	3.73 + 0.51 = 4.24	7.31	t	3.71 + 0.50 = 4.21	7.42	t

* indicating the satellited chromosome; ◆ indicating the chromosome with a secondary constriction on the long arm

Table 5 Parameters of chromosomes in *Cimicifuga foetida* var. *foetida* from Huadianba, Mt. Cangshan, Dali City, Yunnan Province

2n = 32 = 20m + 8sm + 4st

No.	Relative length	Arm ratio	Type	No.	Relative length	Arm ratio	Type
1	2.74 + 1.90 = 4.64	1.44	m	17	1.64 + 1.54 = 3.18	1.06	m
2	2.13 + 1.73 = 3.86	1.23	m	18	1.69 + 1.33 = 3.02	1.27	m
3	2.11 + 1.69 = 3.80	1.24	m	19	1.69 + 1.28 = 2.97	1.32	m
4	2.11 + 1.69 = 3.80	1.24	m	20	1.69 + 1.24 = 2.93	1.36	m
5	2.09 + 1.58 = 3.67	1.32	m	21	1.94 + 1.01 = 2.95	1.92	sm
6	1.96 + 1.69 = 3.65	1.15	m	22	1.94 + 0.95 = 2.89	2.04	sm
7	1.90 + 1.69 = 3.59	1.12	m	23	1.94 + 0.84 = 2.78	2.30	sm
8	1.90 + 1.69 = 3.59	1.12	m	24	1.92 + 0.86 = 2.78	2.23	sm
9	1.88 + 1.69 = 3.57	1.11	m	25	1.69 + 0.63 = 2.32	2.68	sm
10	1.90 + 1.66 = 3.56	1.14	m	26	1.47 + 0.84 = 2.31	1.75	sm
11	1.79 + 1.69 = 3.48	1.05	m	27	1.58 + 0.65 = 2.23	2.43	sm
12	1.90 + 1.56 = 3.46	1.21	m	28	1.37 + 0.73 = 2.10	1.87	sm
13	2.15 + 1.28 = 3.43	1.67	m	29	1.90 + 0.38 = 2.28	5.00	st
14	1.79 + 1.58 = 3.37	1.13	m	30	1.90 + 0.38 = 2.28	5.00	st
15	2.00 + 1.37 = 3.37	1.45	m	31	1.94 + 0.33 = 2.27	5.87	st
16	2.00 + 1.33 = 3.33	1.50	m	32	1.94 + 0.33 = 2.27	5.87	st

Although the tetraploid plants studied here were basically the same as the diploid ones in most of the diagnostic gross-morphological characters, the former were usually robuster and higher, and the leaflets and fruits were much larger. In the field, it is thus not difficult to tell the tetraploid plants from the diploid ones in most cases. As the size of plant organs are apt to be modified by environmental factors, further research in cytology and gross-morphology is needed to decide whether the tetraploid cytotype is worthy of taxonomic recognition.

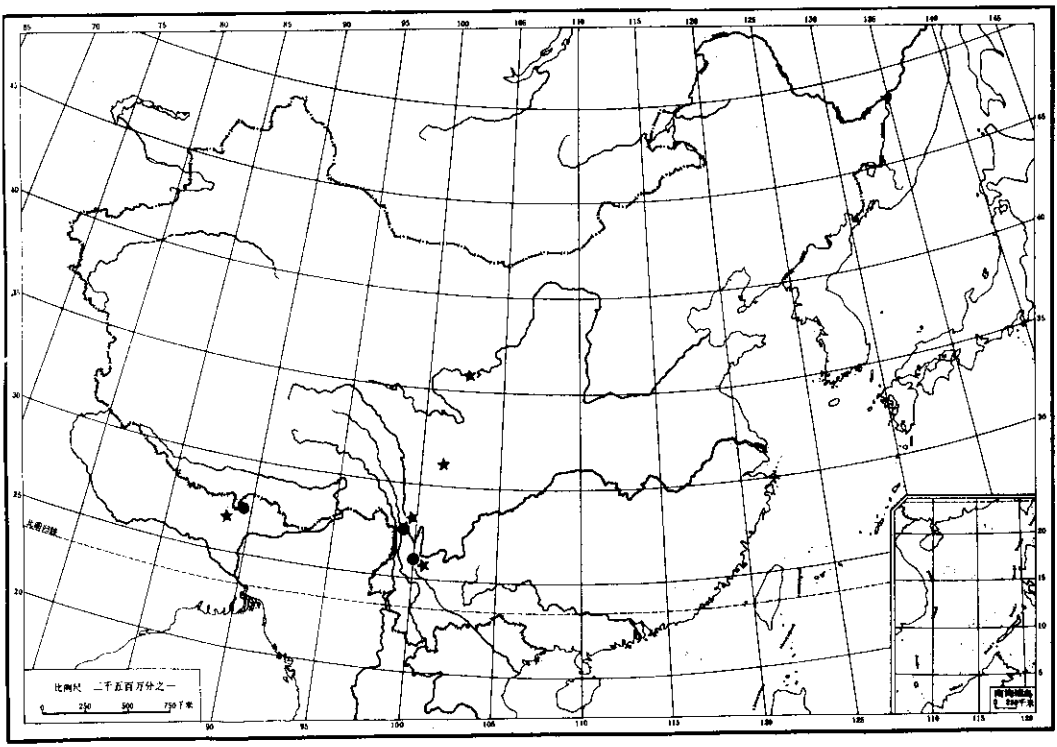

Fig. 5　A map showing the distribution of diploid and tetraploid cytotypes of *C. foetida* var. *foetida* in China and the Himalayas. ★ = diploid, ● = tetraploid.

(b) var. *velutina* Franch. ex Finet et Gagnep.

The chromosomes of this variety were counted to be 2n = 16(Fig. 3:6; Fig. 4:5), ranging in length from 12.22 to 6.44 μm. The karyotype was formulated as 2n = 16 = 10m(1sat) + 4sm(1sec) + 2t(1sat)(Table 4). A quite large satellite(approximately 1.34 μm long) was observed on the short arm of the seventh chromosome. In the distal region of the long arm of the 13th chromosome, a secondary constriction was clearly visible. A very small satellite was observed on the short arm of the 15th chromosome. The chromosome number and karyotype of this variety are reported here for the first time.

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